CLAIMS

What is claimed is:

1. A drug injector configured to inject a drug to a depth beneath an animal's skin comprising:

a chamber for holding a drug to be injected into a biological body;

a nozzle in fluid communication with the chamber, the drug being injected though the nozzle;

a piston positioned within the chamber; and

an actuator coupled to the piston, the actuator including a member that contracts when a potential is applied to the member, the actuator moving the piston towards the nozzle when the potential is applied to the member to expel the drug out of the chamber through the nozzle, thereby delivering the drug to a depth beneath an animal's skin.

2. The drug injector of claim 1 further comprising an inlet port for filling the chamber with the drug.

3. The drug injector of claim 1 further comprising a resilient member that applies a force to the piston away from the nozzle.

4. The drug injector of claim 3 wherein the resilient member is a coiled spring.

5. The drug injector of claim 1 wherein the member is one or more wires of shape memory material.

6. The drug injector of claim 5 wherein the shape memory material is a shape memory polymer.

7. The drug injector of claim 5 wherein the shape memory material is a shape memory alloy.

8. The drug injector of claim 7 wherein the shape memory alloy is selected from the group including: Ag-Cd, Au-Cd, Au-Cu-Zn, Cu-Al, Cu-Al-N, Cu-Zn, Cu-Zn-Al, Cu-Zn-Ga, Cu-Zn-Si, Cu-Zn-Sn, Fe-Pt, Fe-Ni, In-Cd, In-Ti, Ti-Nb, and combinations thereof.

9. The drug injector of claim 7 wherein the shape memory alloy is Ni-Ti.

10. The drug injector of claim 7 wherein the shape memory alloy structure changes phase from martensite to austenite when the potential is applied to the member.

11. The drug injector of claim 1 wherein the chamber is coupled to a reservoir, the reservoir containing enough drug for multiple injections.

12. The drug injector of claim 1 further comprising a sterile interface positioned between the nozzle and the body.

13. The drug injector of claim 12 wherein the sterile interface is a flexible ribbon supplied from a roller, a new sterile portion of the ribbon being positioned over the nozzle after an injection.

14. The drug injector of claim 1 wherein the chamber receives a vial, the chamber being located within the vial, and the nozzle being associated with the vial.

15. The drug injector of claim 14 wherein a plurality of vials are sequentially supplied to the injector, a new vial being positioned in the injector after an injection.

16. The drug injector of claim 1 further comprising:

a skin sensor that measures skin properties of the body; and

a servo-controller coupled to the drug injector and the skin sensor, the servo-controller adjusting the injection pressure of the drug injector to selectively deliver the drug to the body based on the skin properties.

17. A drug injector configured to inject a drug to a depth beneath an animal's skin comprising:

a housing;

a vial positioned within the housing, the vial holding a drug to be injected into a biological body;

a nozzle associated with the housing through which the drug is injected;

a piston positioned within the housing; and

an actuator coupled to the piston, the actuator including a member of shape memory alloy, the actuator moving the piston towards the nozzle of the vial when a potential is applied to the member to expel the drug out of the vial through the nozzle, thereby delivering the drug to a depth beneath an animal's skin.

18. The apparatus of claim 17 wherein the drug is expelled through the nozzle with an injection velocity of at least about 100 meters per second.

19. A drug injector configured to inject a drug to a depth beneath an animal's skin comprising:

a housing;

a vial positioned within the housing, the vial holding a drug to be injected into a biological body;

a nozzle associated with the vial through which the drug is injected;

a piston positioned within the housing;

an actuator coupled to the piston, the actuator including a member of shape memory alloy, the actuator moving the piston towards the nozzle of the vial when a potential is applied to the member to expel the drug out of the vial through the nozzle;

a skin sensor that measures skin properties of the body; and

a servo-controller coupled to the actuator and the skin sensor, the servo-controller adjusting the injection pressure of the drug injector based on the skin properties.

20. A method of injecting a drug into a biological body comprising:

holding a drug in a chamber, the chamber being in fluid communication with an nozzle through which the drug is injected;

applying a potential to a member of an actuator, the member contracting upon the application of the potential, the actuator being coupled to a piston, the actuator moving the piston towards the nozzle when the potential is applied to the member; and

expelling the drug from the chamber through the nozzle as the piston moves towards the chamber.

21. The method of claim 20 wherein the drug is expelled through the nozzle at an injection velocity of at least about 100 meters per second.

22. The method of claim 20 further comprising moving the piston away from the nozzle with a spring when the potential is removed from the actuator.

23. The method of claim 20 further comprising supplying drug from a reservoir coupled to the chamber.

24. The method of claim 20 further comprising positioning a sterile interface positioned between the nozzle and the body.

25. The method of claim 24 further comprising supplying the sterile interface as a ribbon from a roller, a new sterile portion of the ribbon being positioned over the nozzle after an injection.

26. The method of claim 20 further comprising receiving a vial in the chamber, the chamber being contained within the vial, and the nozzle being associated with the vial.

27. The method of claim 26 further comprising supplying a plurality of vials to the injector in a sequential manner, a new vial being positioned in the injector after an injection.

28. The method of claim 20 wherein the member includes a shaped memory material.

29. The method of claim 28 wherein the shape memory material is a shape memory polymer.

30. The method of claim 28 wherein the shape memory material is a shape memory alloy.

31. The method of claim 30 wherein the shape memory alloy is selected from the group including: Ag-Cd, Au-Cd, Au-Cu-Zn, Cu-Al, Cu-Al-N, Cu-Zn, Cu-Zn-Al, Cu-Zn-Ga, Cu-Zn-Si, Cu-Zn-Sn, Fe-Pt, Fe-Ni, In-Cd, In-Ti, Ti-Nb, and combinations thereof.

32. The method of claim 20 wherein the member is one or more wires of shape memory alloy.

33. The method of claim 32 wherein the shape memory alloy is Ni-Ti.

34. A method of injecting a drug into a biological body comprising:

positioning a drug vial in a housing, the vial containing a drug to be injected into the body, and having an nozzle through which the drug is injected;

applying a potential to a member of shape memory alloy, the member forming part of an actuator coupled to a piston positioned in the housing, the actuator moving the piston towards the nozzle when the potential is applied to the member; and

expelling the drug from the vial through the nozzle as the piston moves towards the nozzle.

35. The method of claim 34 wherein the drug is expelled through the nozzle at an injection velocity of at least about 100 meters per second.